ANALYSIS OF FINANCIAL BUDGETING USING COMPUTATIONAL INTELLIGENCE APPROACHES: NEED AND IMPORTANCE IN REFERENCE TO THE STATE OF UTTARAKHAND

A

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ABSTRACT

The complexity and volume of financial data in the public sector demands intelligent tools for effective budgeting and decision-making. Our research will explore the integration of computational intelligence approaches using mathematical models for financial budgeting in the context of the state of Uttarakhand. It aims to evaluate the potential of these tools in improving accuracy, transparency, and efficiency in the budgeting process of Uttarakhand. The research will highlight the limitations of traditional budgeting methods, identify key challenges in financial governance in Uttarakhand, and propose a model for applying computational intelligence to enhance forecasting, resource allocation, and monitoring of financial plans. The study aims to highlight the significant fact that adopting such techniques not only ensures data-driven decision-making but also strengthens the financial management capabilities of the state, paving the way for smart and sustainable governance.

Keywords - Financial Budgeting, Artificial Intelligence, Computational Intelligence, Machine Learning, Big Data Analytics, Public Finance, Uttarakhand, Resource Optimization

1. Introduction:

In the modern era of public administration, financial budgeting stands as a cornerstone for effective governance, economic planning, and equitable resource distribution. States such as Uttarakhand, where the economies are fragile and there is need for complex development, budget in such states are not only financial ledger but it is a strategic tool which help in translating priorities of policies into actionable outcomes. Budgeting helps in determining the allocation of limited public resources to different competing sectors, regions as well as social groups – thus impacting each sectors like healthcare, disaster, education, conservation of environment etc.

Uttarakhand being its locality in ecologically sensitive region of Himalayas is marked with many geographical challenges along with frequent natural disasters and less scope for industrialization. Uttarakhand is also having 65% of it's population residing in rural areas which are often in remote region, which focus towards ned for customization along with need-based strategies of public expenditure. It is also point to focus that the financial landscape of Uttarakhand is constrained, where the scope for internal revenue generation is limited and also major portion of it's finance depends on grants and loan from central. Major economies of Uttarakhand is depending on agriculture, tourism, horticulture and remittance sectors which are vulnerable to change in climate, variation in season along with shift in global economy.

The budget-making process in Uttarakhand adheres to a structured framework, aligning with constitutional mandates and financial protocols.

The directorate of budget which lies under Department of Finance, orchestrates this process and prepare annual financial statement after coordinating with various departments of the state government. The annual finance statement helps in getting estimated figures of revenues and expenditure for a financial year which is further presented in legislative assembly of particular state for final approval. Due to hilly structure of state of Uttarakhand, the natural calamities like recurrent floods, earthquakes, landslides etc frequently force state for diverting the substantial finds towards relief of disaster and rehabilitation, which often disrupt the budget allocation planning done for a financial year. Thus, there is a need for real-time management of fiscal policies which need to be align with ground realities along with managing the long-term sustainable development goals of the state. With all these constraints, state should move forward for smart, data driven and real-time analysis based budgeting, which supports for managing the anticipate risks, model trade-offs and simulation based outcomes. Thus, there is

need for moving the budgeting system from traditional method to modern IT based budgeting system including the functionality of Artificial Intelligence.

Taking perspective of current budgeting system which uses conventional method for allocation of funds which is based on expenditure done in previous years along with minor adjustment based on inflation or any schemes announced by government. This approach is having many limitations as:

1. **Reactive and Static Nature:** One of the main issue with traditional budgeting is it's non-anticipation of future needs along with non-adaptability to emerging challenges of the state. The traditional approach of budgeting lacks with dynamic forecasting capabilities which is one of the major aspects as compared to state of Uttarakhand which is a disaster-prone state and also a state which is rapidly evolving as compared to socio-economic environment.

2. **Misallocation of Resources:** Due to absence of advanced IT based technologies like machine learning, deep learning, big data analytics etc., there are issues of over allocation and under utilization of funds required at low priority areas or in high priority areas. In respect to state of Uttarakhand where situation like disaster, healthcare and critical environmental condition need for advanced technology is need of an hour.

3. **Errors due to Human and manual Process:** Normal human or manual process involves the use of spreadsheets, excel etc. for storing the data of budget and also using the manual way of entering the data leads to issues such as inefficiency, delays along with inaccuracy of data, which is one of the major setback for financial planning and it's execution.

4. **Non-transparency and un-accountability:** The traditional way of financial management doesn't support for real-time monitoring of data also the traditional analytics tools restrict from internal audit and oversight of public at large which may increase the risk for mis-allocation along with non-performance.

5. **Inadequate Use of Data:** Budget decisions are often not based on granular, real-time socio-economic or demographic data, resulting in a mismatch between policy intentions and ground-level realities.

6. **Fragmented Planning:** Traditional budgeting often operates in departmental silos, lacking an integrated approach that considers cross-sectoral linkages and long-term impact assessments.

Given these limitations, there is an evident mismatch between the capabilities of traditional budgeting tools and the complex, data-driven demands of modern financial governance—especially in a resource-constrained and disaster-vulnerable state like Uttarakhand.

2. Research Problem:

Despite the critical role of financial budgeting in enabling effective governance and sustainable development, the current budgeting practices in the state of Uttarakhand largely relies on traditional and manual methods that lack predictive accuracy, data integration, and responsiveness to socio-economic and environmental variables.

With the growing complexity of fiscal planning—especially in a geographically sensitive and disaster-prone region like Uttarakhand—there is a need for intelligent, data-driven, and adaptive budgeting systems.

Public finance at state level is still unutilized with recent developed computational intelligence techniques like machine learning, deep learning or generative artificial intelligence, neural networks etc. Existing financial system of Uttarakhand is also fails in incorporating real-time data, inputs from multiple sources or simulating multiple policies scenarios for supporting evidence based decision making. Thus, this all marks a need for use of computational based techniques in budgeting system specially with respect to state of Uttarakhand which is more prone to disaster related issues where dynamic budgeting and real-time budgeting system is need of the hour and will also helps in increasing the transparency in the budgeting system of Uttarakhand. Use of computation intelligence techniques in budgeting of Uttarakhand will help in increasing the efficiency, accuracy along with resilience of financial budgeting process of state of Uttarakhand. Our research is focussed to address the same issue of budgeting system of Uttarakhand where applying of computational intelligence on budget of Uttarakhand will be studied for prediction of future budgeting process along with decision making based on real time data.

3. Literature Review:

For selection of literature, Snowball Approach technique is used. The Snowball Approach technique was largely adopted for a comprehensive study about the topic. Initial source selection was done by collecting research papers, books, and reports from reputable databases such as IEEE, Springer, Elsevier, and Shodh Ganga. After reviewing the initial papers, citations and references within those studies were examined and relevant works on financial planning, AI,

mathematical modeling, and government-level budgeting were identified and included in the review.

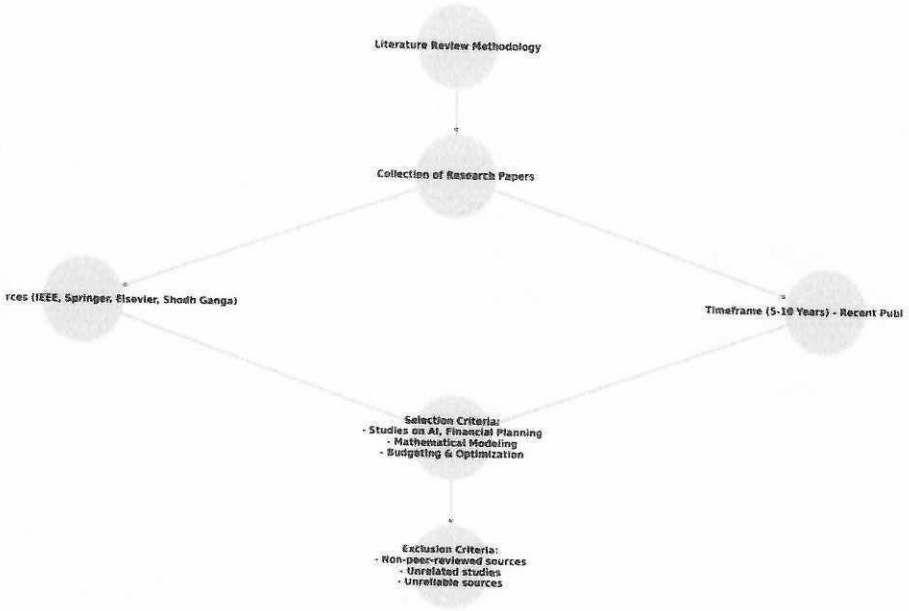

Fig. 1: Literature Review Methodology

As more studies were collected, strict inclusion and exclusion criteria was applied for filtering and refinement. Studies outside financial planning, resource optimization, or AI applications were discarded. Non-peer-reviewed and unreliable sources were also excluded to maintain academic integrity. The accumulated literature is now synthesized to form a comprehensive, up-to-date perspective on financial planning and budgeting. The iterative nature of this approach allows for a progressive expansion of sources, ensuring that the study remains comprehensive, relevant, and well-grounded in existing research

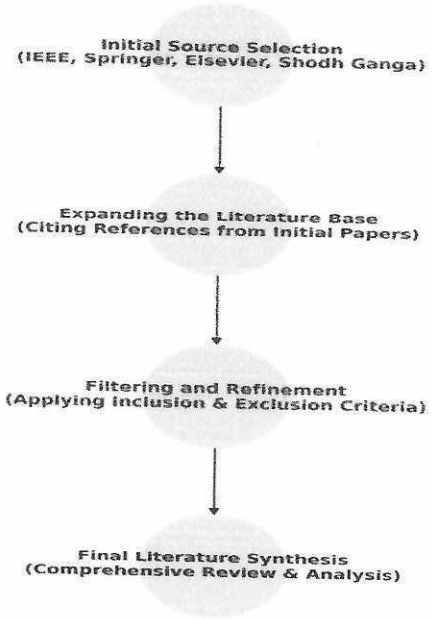
Initial Source Selection
(IEEE, Springer, Elsevier, Shodh Ganga)
Expanding the Literature Base
(Citing References from Initial Papers)
Filtering and Refinement
(Applying Inclusion & Exclusion Criteria)
Final Literature Synthesis
(Comprehensive Review & Analysis)

Fig. 2: Process of Literature synthesis

3.1 REVIEW ANALYSIS OF FINANCIAL BUDGETING

The papers that use different computational approaches for financial budgeting were explored and further classified into three categories based on technologies used for financial budgeting namely traditional mathematical approach, artificial intelligence approach and big data approach.

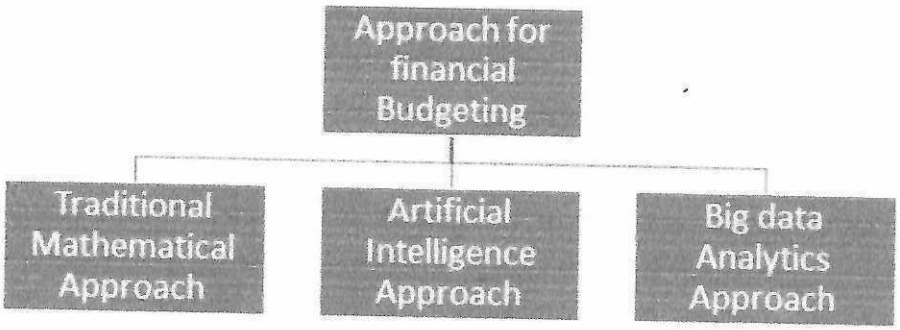

Fig. 3: Classification of Financial budgeting methods

3.2 Traditional Mathematical Approach for Financial Management:

D. Acharya et. al., 2009, perform their study on net state domestic product (PCNSDP) and per capita credit (PCC) for 14 Indian states. This study is from 1981-2002 for 14 states- Andhra

Pradesh, Assam, Bihar, Gujarat, Haryana, Kerala, Maharashtra, Madhya Pradesh, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal. In this research Pedroni Panel Co integration Test and Fully Modified Ordinary Least Squares (FMOLS) regression were used for analyzing relation between financial development and economic growth with Vector Auto regression (VAR) was employed to address endogeneity. They classify data into backward states, which they termed as BIMAARU and developed states. The states which have weaker credit output were categorized as BIMAARU states which need regulatory intervention and need for addressing structural issues in real sector. The study shows that the financial development will positively help in influencing economic growth for BIMAARU as well as non-BIMAARU states.

Zhang J and Su M., proposed a framework for evaluation of science and technology (sci-tech) financial ecosystems for various countries which helps in integrating finance with technological innovation. Overall evaluation is done on enterprise financing capabilities, enterprise innovation capability, fintech development, government service capacity, degree of financial openness and index system design. The study was conducted by collection of data from 2010 to 2019 followed by processing of data along with assigning the weights and finally applying structured methodology for a nuanced comparison of countries' sci-tech financial ecosystems, providing insights into their respective strengths and demarcation of areas that need development.

Chakrabarti D. et.al., 2018 make use of theoretical model and empirical analysis for examining the directed credit policies on financial development, financial liberalization, firm financing and economic growth. The study conducted on 932 Indian manufacturing firm from year 1990-2016. The research make use of panel data analysis, ARDL modeling and structure break test which helps in indicating that liberalization shifted firms towards equity financing. The research reveals that credit program can support financial development and economic growth under specific conditions.

3.3 Artificial Intelligence Approach for Financial Management:

Broby D., 2022 presents a survey paper where financial analytics is explained using computational techniques. This paper uses methods of classification, regression, clustering, and association along with time series model. This specifies that external data can be used to forecast the economy and corporate earnings. This analytics is performed using predictive models which analyze external data using historic time series to forecast the returns. It is mentioned that the descriptive data is used in finance for quantifying the relationship, thus helping in prediction of risks.

Chakri P. et. al., 2023 explores the use of data analytics for financial accounting including of income statements, balance sheets and cash flow statements using four AI based approach namely Linear regression, K-nearest neighbor, support vector regressor and decision tree model. It was found that out of these four, decision tree model results in optimized performance with maximum depth of nine by means of grid search. The indicators used for evaluation of performance are debt-to-equity, EPS, Inventory turnover and net margin.

Yanga R. et. al., 2019 uses big data analytics for forecasting the financial market volatility based on AI based support vector machine (SVM) model. This paper proposed two prediction methods based on neural network, namely time window static network prediction and recursive dynamic network prediction. SVM is used for prediction of financial data. This paper studies the application of a new type of neural network-support vector machine in financial forecasting. This paper analyses Shanghai stock market using non-linear prediction. CARRX model is proposed in this approach where least squares support vector machine (LSSVM) is applied to the proposed model. The prediction accuracy of the proposed model is better than any previous model and algorithms. Financial forecasting is done using SVM and regression forecasting model of least squares support is constructed accordingly.

Akanni A in 2024 make use of AI in financing and budgeting by taking case studies. They make use of machine learning for analysis of historical and real-time data which helps in enabling model creation which helps in predicting future financial prediction with better precision. For complex models and finding relationship between non-linear values neural network is used. Multitude of variables along with their interactions provide further enhancement to working of proposed model. The predictive analysis of the financial data of an organization helps in foreseen the outcomes along with adjustment of the organization strategies in a more elaborative manner and helps in decision making and thus helps in proactive approach rather than reactive approach towards financial management of an organization. Further, the quantitative analysis of AI-driven budgeting models helps in providing valuable insight for potential of AI to enhance dynamic budgeting and forecasting.

Vineet Jain and Parth Kulkarni in year 2023 uses AI techniques for enhancing to forecast of finance and budget strategies. AI techniques in this approach helps in automatic resource allocation along with real-time adjustment of resource for finance and budget data is done. Thus, this approach is beneficial for financial planner in concentrating their approach towards analysis of strategic planning, alignment of financial strategies seamless with organizational objectives.

Wasserbacher H. et. al., 2022 uses machine learning for forecasting, planning and analysis of financial data. In this paper, they make use of simulation approach to explain how machine learning can be used for forecasting and planning. They make use of Naïve application of machine learning for simulation purpose. The simulation design helps in projecting the settings, data types and questions that a planning and analysis department of a company could face. The main focus of this research is on accuracy of sales forecasting and effectiveness of promotional activities in promotion of sales.

Chen and Yaping, 2021 explain the uses of artificial intelligence in financial and accounting management systems. This is explained using intelligent accounting model which helps in enhancing efficiency, financial process optimization along with support for real-time decision making. This paper proposed three AI driven algorithm as Earliest Deadline First (EDF), Highest Value First (HVF), and Highest Value Density First (HVDF) which helps in enhancing the financial management. The paper also proposes shared accounting service model meant for centralized operations and real-time analysis.

Wall L., 2018 explain the regulatory implication of AI in finance. In this research the focus is on impact of machine learning on financial services, compliances and supervision is discussed. Qualitative and analytical approach is used for studying of financial regulations, different case studies and industry reports which helps in revealing that AI helps in improving the compliance checks, fraud detection as well as risk assessment.

Rajeshwari M. et. al., 2022 develop an AI-driven financial management system by making use of parallel computing for enhancing the decision making, risk prediction and increasing the efficiency of SMEs. Integration of AI algorithm is done by using computational and simulation based approach for testing the performance of system for processing of financial data, risk assessment and automation by means of hypothetical scenarios. The results reveals that integration of AI and parallel computing helps in improving accuracy, reduction in processing time along with streamlining the budget and investment plans.

3.4 Big data Analytics approach for Financial Management:

S. Kumar et. al., 2022 discusses about sustainable finance using big data analytics and machine learning. This paper focuses on seven major themes of sustainable finance research namely socially responsible investing, climate financing, green financing, impact investing, carbon financing, energy financing and governance of sustainable financing and investing. This paper proposed framework along with unifying and devising policies for sustainable finance. The paper focusses on impact of latest technologies like machine learning, block chain etc. in

sustainable finance along with their contribution in sustainable finance. The proposed approach involve steps like data collection, data pre-processing, data assembling along with data arrangement followed by data assessment. This all steps helps in analysis of performance along with mapping of science for sustainable finance.

Hasan M. et. al. in year 2020 make use of big data approach in complain of internet credit service, finance market, their management along with their analysis and applications. They also study the analysis of credit banking risk and their management etc. While in their approach, they divide the areas in three groups as big data which is applied in implication of finance market, second implication of big data in internet finance and value creation in internet credit-service companies and third big data in finance and risk analysis and management along with their applications. Further, they conclude that big data plays a major role in all these three financial sectors.

Table 1: Comparative Analysis of financial Budgeting

S.No.	Title of Paper	Tools and Technologies Used	Work Done	Result
1.	Financial development and economic growth in Indian States: an examination	Pedroni Panel Cointegration Test, FMOLS, VAR's	Understand the relationship between credit growth and output growth	Credit-output growth for BIMAARU states is lower
2.	The use of predictive analytics in finance	classification, regression, clustering, association and time series models	Understand the relationship between predictive analytics and finance	Effect of predictive analysis in finance
3.	Past, present, and future of sustainable	Collection, assembling,	Understand seven major	Performance analysis and

	finance: insights from big data analytics through machine learning of scholarly research.	arranging and assessing of data on sustainable finance	themes of sustainable finance	science mapping for sustainable finance
4.	An exploratory data analysis approach for analyzing financial accounting data using machine learning	Linear Regression, K-Nearest Neighbor, Support Vector Regressor, and Decision Tree, grid search	Analyze financial accounting data, balance sheets, income statements, and cash flow statement.	Decision tree model results in optimized performance
5.	Finance for the Environment: A Scientometrics Analysis of Green Finance	Survey paper	Journals and papers related to green finance were discussed	Journals and papers related to green finance were discussed
6.	Construction of Sci-Tech Financial Ecosystem Indicators and International Comparative Research	Index system of Scitech (designing, data processing)	Sci-Tech framework is discussed and comparison of china with other countries is studied	Sci-tech framework developed
7.	Big data analytics for financial Market volatility forecast	hybrid theory and support vector machine	extract the characteristics of financial market, and	Volatility is an important measurement

	based on support vector machine	(SVM) algorithm	analyze the relevant data of financial market.	index of market risk, Prediction of jump volatility and short-term volatility of high-frequency data is done.
8.	Current landscape and influence of big data on finance	Big Data	Analyze the use of big data in managing the financial data	Influence of big data on almost every aspect of financial markets, financial institutionsand so on.
9.	AI in Dynamic Budgeting and Forecasting	AI (machine learning, neural networks, and predictive analytic)	ML is used for analysis of historical and real-time data, enabling the creation of models that can predict future	The quantitative analysis of AI-driven budgeting models provides valuable insights into potential of AI

			financial scenarios.	to enhance dynamic budgeting and forecasting.
10.	Integrating AI Techniques for Enhanced Financial Forecasting and Budgeting Strategies	AI	Discusses uses Artificial Intelligence (AI) for Financial Forecasting and Budgeting for business decision-making	AI helps financial planners to concentrate on strategic analysis, aligning financial strategies seamlessly with organizational objectives.
11.	Machine learning for financial forecasting, planning and analysis: recent development and pitfalls	ML	machine learning for forecasting, planning and analysis of financial data.	Accuracy of sales forecasting and effectiveness of promotional activities achieved.
12.	Framework of the Smart Finance and Accounting	AI	proposed three AI driven algorithm as	enhancing efficiency, financial process

	Management Model under the Artificial Intelligence Perspective.		Earliest Deadline First (EDF), Highest Value First (HVF), and Highest Value Density First (HVDF)	optimization along with support for real-time decision making
13.	Directed credit, financial development and financial structure: theory and evidence	theoretical model and empirical analysis	examining the directed credit policies on financial development, financial liberalization, firm financing and economic growth.	credit program can support financial development and economic growth under specific conditions.
14.	Optimal Analysis for Enterprise Financial Management Based on Artificial Intelligence and Parallel	AI	develop an AI-driven financial management system by making use of parallel computing for enhancing the decision making, risk	integration of AI and parallel computing helps in improving accuracy, reduction in processing time along with streamlining

	Computing Method		prediction and increasing the efficiency of SMEs.	the budget and investment plans.

Table 1 shows the representation of papers in the field of financial budgeting based on parameters like technology used, work done and results.

3.5 Bibliometric Analysis: Bibliometric analysis is performed in order to understand the research trends of the journals in the area. Bibliometric analysis is also used to show how the artificial intelligence and machine learning is shifting the trends from traditional mathematical approach to new AI based mathematical approach. The analysis involved

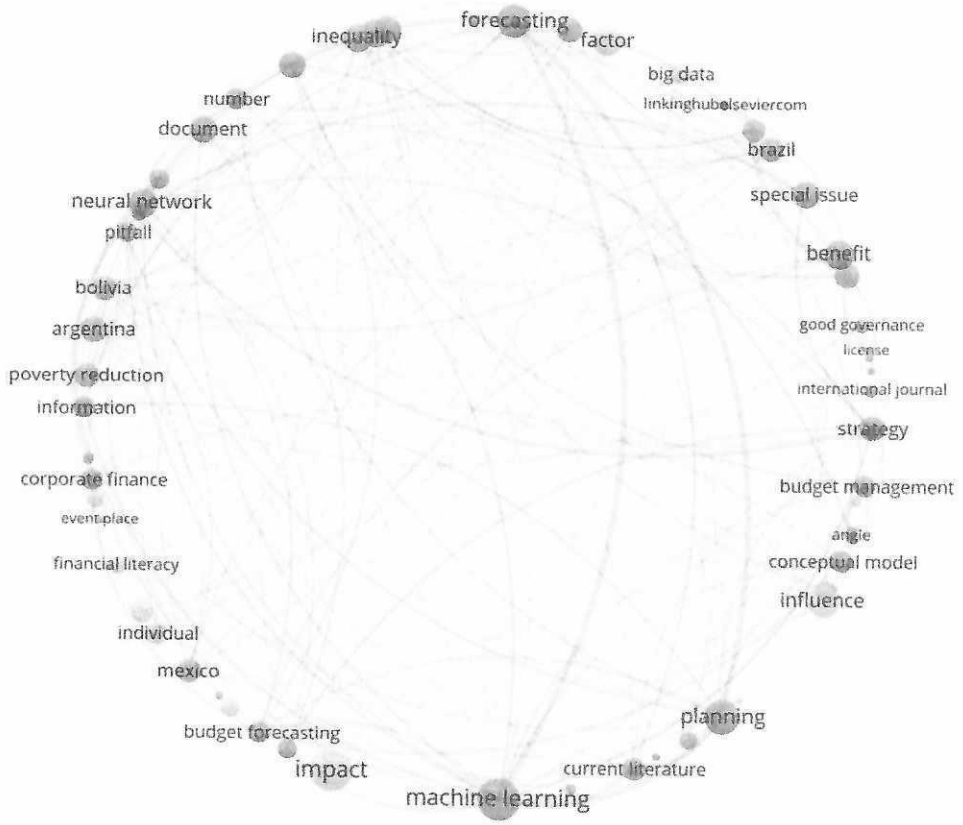

Fig 4: Bibliometric analysis of impact based analysis

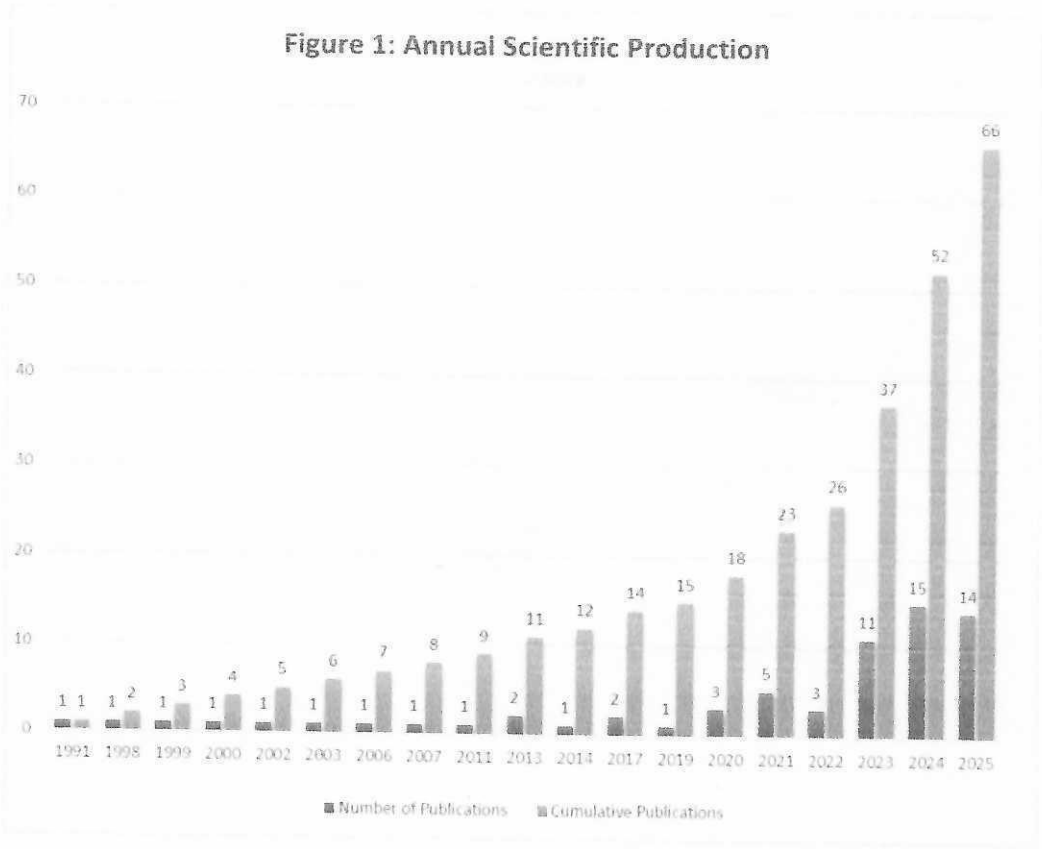

Fig 5: Bibliometric analysis of Year wise trends

Fig 6: Bibliometric analysis of factors used for analysis

Fig 7: Bibliometric analysis of topic wise trends

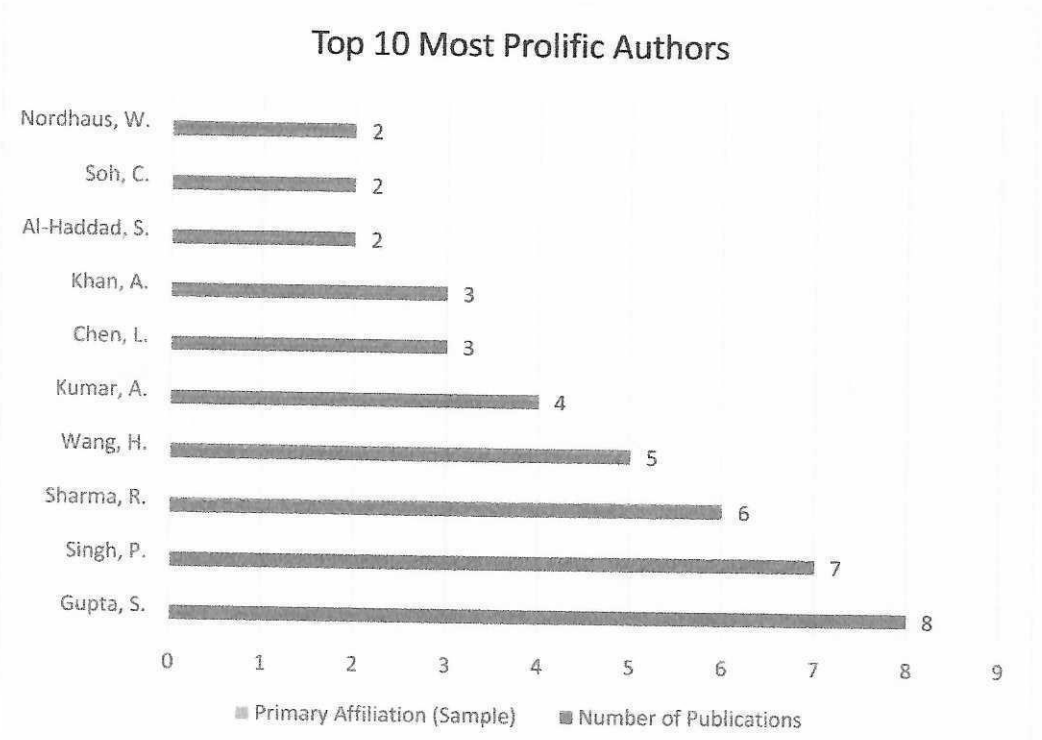

Fig 8: Top 10 most profile authors

3.6 Articles related to Literature Review:

Table 2: Literature review of work done in financial budgeting

Sr No	Title	Author(s)	Publisher	Year	Key Findings	Research Gaps
1	Can Artificial Intelligence Help Optimize the Public Budgeting Process?	Vanessa Fernandez-Cortez, David Valle-Cruz, J. Ramon Gil-Garcia	IEEE	2020	Proposed a methodology using genetic algorithms to optimize Mexico's public budget. Found that AI improved planning-stage decisions and aligned resource allocation with social needs.	Lack of consideration for political/environmental factors; limited to simulation and not real-world deployment; no regional/state-specific adaptation such as Uttarakhand.
2	A Funding Choice Decision Model for Financing Promising E-Government Services	Rosemary Wild & Kenneth Griggs	Inderscience	2006	Identified funding challenges for innovative IT services in government. Proposed decision model to select non-traditional funding mechanisms.	Lacks application to AI-specific budgeting tools; does not explore computational models for optimization or AI integration in budgeting.
3	Factors for a Successful Adoption of Budgetary Transparency Innovations	Gabriel Puron-Cid	Government Information Quarterly	2014	Highlights the Mexican initiative PbR-SED using new tech for budget transparency. Found collaboration, knowledge, and trust crucial for successful tech adoption in budgeting.	Focuses on transparency and adoption, not optimization or computational approaches like AI. No state-specific or Indian context.
4	Creating Public Value Through Smart Technologies: from digital service to AI & beyond	Criado & Gil-Garcia	International Journal of Public Sector Management	2019	Argues AI and emerging tech enhance public value when integrated with budgeting and governance.	Needs further empirical validation; does not address regional constraints in resource-poor states like Uttarakhand.

					Emphasizes smart decision-making and data integration.	
5	Artificial Neural Networks: Fundamentals, Design and Application	I.A. Basheer & M. Hajmeer	Elsevier	2000	Provided a comprehensive overview of ANN design and training. Demonstrated use in modeling nonlinear, uncertain environments.	Application focused on microbiology, not finance or public budgeting. Highlights technical potential but lacks public sector linkage.
6	Integrating AI Techniques for Enhanced Financial Forecasting and Budgeting Strategies	Vineet Jain, Parth A. Kulkarni	IJEMS	2023	Demonstrated how AI improves forecasting accuracy and optimizes resource allocation in financial planning.	Focus is on corporate finance; lacks public sector/state-level applications like Uttarakhand.
7	Optimized Financial Planning: Integrating Individual and Cooperative Budgeting Models with LLM Recommendations	de Zarzà I. et al.	MDPI - AI Journal	2024	Proposed AI-enhanced optimization models for individual and household budgeting using LLMs.	No application in institutional or government-level budgeting.
8	Budget and Expense Tracker	Kamakhya Singh et al.	IJERD	2024	Developed a web-based platform for budget tracking with real-time updates and automated categorization.	Tool is individual-focused, not scaled for government/public finance use like Uttarakhand.
9	AI-Driven Personal Finance Management Tools	Sai Deepak Talasila	IRJET	2024	Found that AI improved savings, investment returns, and financial goal achievement significantly compared to traditional methods.	Study is consumer-focused; lacks relevance to state-level financial budgeting.

10	Industry 4.0 in Finance: The Impact of Artificial Intelligence on Digital Financial Inclusion	David Mhlanga	Int. J. of Financial Studies	2020	AI enhances financial inclusion by addressing risk, reducing asymmetry, and supporting digital transactions.	Focuses on inclusion, not budgeting systems; lacks regional/state application like Uttarakhand.
11	Classification-Based Financial Markets Prediction using Deep Neural Networks	Dixon, Klabjan, Bang	arXiv	2016	Demonstrated that deep learning can predict financial market trends better than traditional models.	Targets market prediction, not public budgeting; lacks geographic specificity.
12	Budgeting in the Age of Artificial Intelligence: New Approaches, Old Challenges?	Gianfranco Marotta, Cam-Duc Au	Int. Journal of AI & ML	2022	Explores integration of AI in budgeting to improve efficiency and accuracy while recognizing persistent governance issues.	Lacks regional/state-specific analysis (e.g., India/Uttarakhand); needs empirical testing in low-resource settings.
13	RPA and Artificial Intelligence in Budget Management Based on Network Communication	Haiying Luo, Haichang Luo	Wireless Comm. & Mobile Computing	2021	Demonstrated how AI and RPA streamline financial processes and improve budget accuracy through automated recognition models.	Focuses on enterprise/corporate use; does not explore public or government budgeting frameworks.
14	Artificial Intelligence in Finance: A Comprehensive Review	Salman Bahoo et al.	SN Business & Economics	2024	Identifies key AI applications in finance: forecasting, classification, and risk evaluation; emphasizes rapid growth in research.	Mostly macro-level and global; lacks insights into public budgeting and Indian regional implementations.
15	Budgeting and Finance	Md Nurul Momen, Z.R.M. Abdullah Kaiser	Springer	2019	Reviews traditional public budgeting systems, emphasizing structured financial	No use of AI or computational intelligence; lacks modern analytical frameworks and local application to Uttarakhand.

					planning and governance.	
16	The Importance of Financial Planning and Budgeting in Managing Corporate Finance	Khalida Aziz, Dr. Shailja Dixit	IJRPR	2024	Discusses best practices and strategic importance of budgeting in corporate environments.	Not computationally driven; doesn't extend to public finance or AI methodologies.
17	Design of a Rule-Based Personal Finance Management System	Alhanoof Althnian	IJACSA	2021	Proposes a rule-based PFM system using deductive reasoning for real-time budget decisions.	Focuses on personal finance; lacks scalability to state or public-level financial systems.
18	Impact of Financial Literacy, Mental Budgeting & Self-Control on Financial Wellbeing	Ruofan Bai	PLoS ONE	2023	Confirms financial literacy and budgeting improve well-being; decision-making mediates impact.	Centers on personal finance in China; no AI component or application to regional/state budgeting.
19	Capital Budgeting in Governments: The Feasibility of Artificial Intelligence Technology	Anita S. Hollander & Rhoda C. Icerman	Expert Systems with Applications	1991	Discusses expert systems in governmental budgeting; finds AI has potential to support capital planning in public sector.	No real-time or region-specific application; lacks modern ML methods; outdated tech context.
20	Social Spending, Human Capital, and Growth in Developing Countries	Baldacci, Clements, Gupta & Cui	World Development	2008	Establishes strong link between public social spending and growth via improved human capital.	No direct computational budgeting approach; focuses on education/health investment, not financial optimization.
21	Fiscal Redistribution and Income Inequality in Latin America	Edwin Goni, J.H. López, L. Servén	World Development	2011	Fiscal policies help income equity via transfers and social spending; shows redistributive limits of tax systems in developing regions.	Focus is Latin America; lacks computational analysis or AI-driven budgeting mechanisms.

22	The Effectiveness of Government Spending on Education and Health	Gupta, Verhoeven, Tiongson	Eur. J. of Political Economy	2002	Confirms education/health spending improves human development; emphasizes budget targeting efficiency.	Does not apply or analyze AI-based budget planning; no subnational or Indian context.
23	Governance Matters III	Kaufmann, Kraay, Mastruzzi	World Bank Economic Review	2004	Provides governance indicators useful for linking AI-driven budgeting to institutional quality metrics.	Doesn't explore AI budgeting or financial modeling; governance data may lack granularity for Uttarakhand.
24	Poverty Reduction and Good Governance	Huck-ju Kwon, Eunju Kim	Development and Change	2014	Argues that governance alone is insufficient for poverty reduction; recommends structural reforms.	Lacks direct focus on budgeting or AI; not contextualized to India or state finance.
25	Does Government Spending Affect Income Inequality?	Anderson, Jalles D'Orey, Duvendack, Esposito	Journal of Economic Surveys	2016	Meta-study confirming some forms of government spending (esp. education/social) reduce inequality.	Mixed findings in LICs; doesn't study algorithmic or AI-aided budget efficiency.
26	The Impact of Taxes and Social Spending on Inequality in Latin America	Lustig, Pessino, Scott	Public Finance Review	2014	Highlights mixed impact of tax and spending systems on inequality; health/education transfers most effective.	Focus on Latin America; lacks AI integration or Indian governance applicability.
27	The Effect of Health on Economic Growth: A Production Function Approach	Bloom, Canning, Sevilla	World Development	2004	Empirical evidence links health improvements to productivity and GDP growth.	Doesn't explore budget planning mechanisms or AI; limited to macro health effects
28	Economic Growth and Human Development	Gustav Ranis, Frances Stewart, Alejandro Ramirez	World Development	2000	Established a two-way causal relationship between	Lacks AI/computational budgeting focus; analysis is macro and human

					human development and economic growth; emphasized sequencing and feedback loops.	development-centric, not finance-oriented.
29	Corruption and the Composition of Government Expenditure	Paolo Mauro	Journal of Public Economics	1998	Found that corruption distorts public spending—reducing education and health budgets in favor of rent-seeking sectors.	Does not explore budgeting tools or AI; insights are institutional, not technical or region-specific
30	Machine learning for financial forecasting, planning and analysis: recent developments and pitfalls	Wasserbacher, Helmut; Spindler, Martin	Digital Finance	2022	Machine learning is well-suited for automated information extraction in financial forecasting, planning, and analysis (FP&A). The "double machine learning" framework can address causal questions relevant to planning and resource allocation. Forecasting and planning improve with increased data points.	Need for careful application to avoid pitfalls when using ML for planning and resource allocation (causal inference) rather than just forecasting (prediction).
31	AI in Dynamic Budgeting and Forecasting	Akanni, Abimbola Olukayode	European Journal of Business and Innovation Research	2024	AI significantly enhances the accuracy, efficiency, and adaptability of financial forecasts and resource allocation by processing vast datasets, identifying hidden patterns, and	Need for further exploration of theoretical underpinnings and practical applications, especially concerning the integration of AI tools with existing financial systems and the interpretation of AI-generated insights.

					making real-time adjustments. AI-driven budgeting tools reduce forecasting errors and enable swift adaptation to market changes.	
32	Optimal Analysis for Enterprise Financial Management Based on Artificial Intelligence and Parallel Computing Method	Rajeswari, M.; Kumar, N.; Raman, P.; Patjoshi, Pramod Kumar; Singh, Vaishali; Pundir, Sumit	IEEE	2022	Discusses the application of AI and parallel computing to enterprise financial management.	Specific key findings and research gaps are not detailed in the provided abstract, indicating a need to access the full article for this information.
33	Current landscape and influence of big data on finance	Hasan, Md. Morshadul; Popp, József; Oláh, Judit	Journal of Big Data	2020	Big data significantly impacts financial products and services, influencing financial markets, institutions, fraud detection, risk analysis, and financial application management. It is an emerging issue for data management and analytics in finance.	As big data in finance is a new concept, future research directions need to be explored.
34	The use of predictive analytics in finance	Broby, Daniel	The Journal of Finance and Data Science	2022	Explores the application of predictive analytics in finance.	Specific key findings and research gaps are not detailed in the provided abstract, indicating a need for deeper analysis of the full article.
35	Framework of the Smart Finance and Accounting Management Model under the Artificial Intelligence Perspective	Chen, Yaping	Mobile Information Systems	2021	Artificial intelligence technology significantly promotes the development of smart accounting management models.	Need for further exploration of specific methods for ensuring objectivity and accuracy in AI-driven accounting models.

					It provides unified and standardized accounting and asset management, improving objectivity and accuracy of evaluation results.	
36	Past, present, and future of sustainable finance: insights from big data analytics through machine learning of scholarly research	Kumar, Satish; Sharma, Dipasha; Rao, Sandeep; Lim, Weng Marc; Mangla, Sachin Kumar	Annals of Operations Research	2022	Provides insights from big data analytics through machine learning in sustainable finance research.	Specific key findings and research gaps are not detailed in the provided abstract, indicating a need for deeper analysis of the full article.
37	Finance for the Environment: A Scientometrics Analysis of Green Finance	Cai, Rui; Guo, Jianluan	Mathematics	2021	Green finance integrates environmental protection and economic profits. The study analyzes publications on green finance, identifying productive entities and visualizing intellectual networks. It highlights developments and trajectories in green finance research.	The study itself provides an analysis of trends, implying a need for continued research into emerging trends and future studies within green finance.

4. Research Gaps:

The literature review helps in analysis of financial budgeting for the state of Uttarakhand and helps to conclude that the traditional approach that is being used is not sufficient and hence there is need for advanced technology based approach for better analysis and management of financial data. The literature review helps in figuring out the following gaps:

i. There are nearly no computational intelligence approach that has been used at state-level for analysis and management of financial data and especially for state of Uttarakhand which is

crucial in terms of their geographical and demographic conditions and hence need for such approach is highly required for Uttarakhand state.

ii. Traditional statistical or regression based tools dominate current budgeting analysis. Advanced computational analysis techniques like deep learning, fuzzy logic, neuro-fuzzy system etc. are underutilized for purpose of financial planning for the state government and especially in context of Uttarakhand.

iii. Uttarakhand financial budgeting system lacks dynamic AI-enabled forecasting models which can update the budgetary projection based on real-time analysis based on certain factors.

iv. Integration of financial data with socio-economic metric along with other factors is an area of research gap which need to be focussed on.

v. Uttarakhand being in seismic zone 5 is prone to disaster and hence need for computation intelligence based approach is much needed for resilient budgeting along with contingency planning

5. Research Objectives:

The proposed research is focusses on investigating the potential of computational intelligence approach for financial analysis and management for the process of budgeting to make it an effective budgeting system. The key objectives of the same are as follows:

- **Evaluating mechanisms of current financial planning used by the state:** First objective of research will be the thorough assessment of existing financial planning and budgeting process of state of Uttarakhand which include allocation of funds, monitoring of funds and utilization of funds across various departments of Uttarakhand. The study will help in finding the effectiveness of current methods adopted for financial planning and analysis which is used for finding the improvement required thereof.
- **Identifying critical inefficiencies and gaps in budgeting processes:** Second objective will be to find the inefficiencies and gaps in budgeting process which include coordination among different departments, misallocation of funds , delay or lack of accountability. There are other areas like error in revenue forecasting, inadequate data-driven decision-making, redundancy in processes, and lack of transparency which need to be addressed and how they impact the budgeting process is an area of focus.
- **Exploring impact of CI techniques to enhance forecasting, resource optimization, and fiscal transparency**: Modern techniques like computational intelligence (CI) including their sub-parts as machine learning, deep learning, computer vision, data mining, big data analytics

etc. have an great potential for transforming the financial planning. The proposed objective will analyze the impact of computational intelligence methods in improving the accuracy, optimizing the allocation of scares resources etc. These advanced technologies will help in minimizing the human interventions, detecting of anomalies while spending along with increasing the transparency in utilization of budget. These approaches also help in real time monitoring of budgets and prepare for adaptive financial strategies.

- **Proposing a framework for the integration of CI tools in Uttarakhand's budgeting workflow:** Our last objective will be to create a framework for budgeting practices using computation intelligence methods. The framework will include the required infrastructure, integration of data, capacity building along with phase wise implementation of budgeting process. Thus, the proposed framework will helps in providing roadmap for sustainable and adaptable Uttarakhand budgeting system.

By introducing computational intelligence into the financial planning ecosystem, the research aims to develop a model that is adaptive, predictive, and optimization driven. Such a model can help policymakers in Uttarakhand simulate different budgetary scenarios, prioritize allocations based on measurable impact, and react swiftly to changing socio-economic conditions. In essence, this study aims to build a case for intelligent budgeting—an approach that not only conserves public funds but also amplifies their developmental value.

6. Research Methodology:

The methodology of the proposed work is divided into following phases:

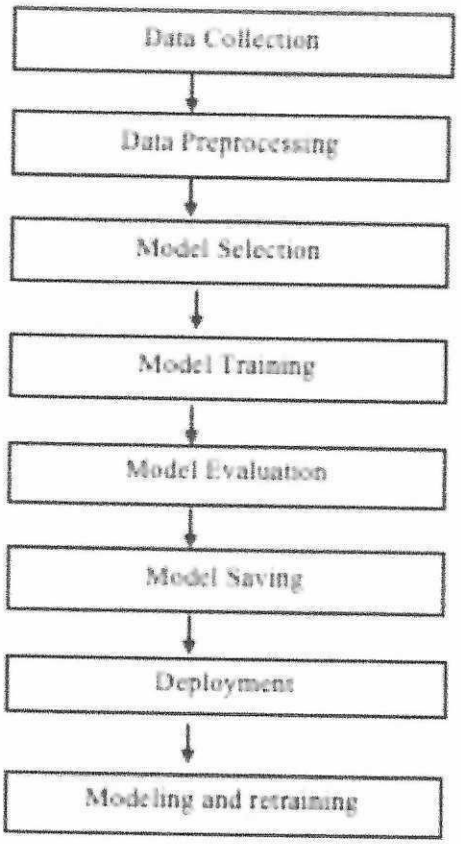

Fig 9: Method and Process of the proposed work

Phase 1: Data Collection:

The process of data collection involves collection of financial data which will be available in .xlsx or .csv file format and will be stored as financial_data.xlsx file with historical data. Our prime goal in data collection process is to load and validate raw data by means of importing pandas as

pd pf= pd.read_excel (financial_data.xlsx)

Phase 2: Data Pre-processing:

The data pre-processing steps involve various methods like handling the missing values from the financial_data.xlsx file, converting dates if needed in date format, converting categorical variables, normalize or scale numerical columns, creating lag features for time-based data by python code

df.fillna(method='ffill', inplace=True) etc.

Phase 3: Model Selection:

Third phase involves selection of model and that is done by tag sector or purpose (Text) ->IndicBERT-base (multi-label) and followed by task 2 as Forecast Spend (Numeric) for which we can use XGBoost (if tabular) or LSTM (if in sequence) transformers, xgboost, tensorflow. For small tabular data, we can try linear regression which is simple, fast and interpretable. Random forest can be used for non-linear data which is used for handling overfitting issues wheras XGBoost is used as powerful tool for tabular data.

Phase 4: Model Training:

Phase 4 involves training of model by splitting the data in two catagories- train and test data. The model is then fitted by means of a Fine-tune IndicBERT using python code pythonModel=AutoModelForSequenceClassification.from_pretrained and training of XGBoost is done by using python code xgb.XGBRegressor(n_estimators=300) Model.fit(X_train, y_train)

Phase 5: Model Evaluation:

Phase 5 involves evaluation of model which is done by using metrics for regression using parameters like MAE (Mean Absolute Error), RMSE (Root Mean Squared Error), R^2 Score by using python code from sklearn.metrics import mean_squared_error, r2_score r2_score(y_test, y_pred)

Phase 6: Model Saving

Phase 6 saves the model by using joblib or pickle to persist the trained model and this is achieved by importing joblib using python code joblib.dump(model, 'revenue_model.pkl')

Phase 7: Deployment

Phase 7 is deployment of model by using Flask or FastAPI backend for serving model as API. Streamlit or Gradio can be used as interactive dashboards. Docker is used for containerization whereas model can be deployed to AWS EC2/ Azure/ Heroku / GCP uvicorn cloud platforms using main:app --reload # for FastAPI Phase

Phase 8: Monitoring & Retraining

Final stage is stage 8 which is monitoring and retraining of the model which is done by monitoring performance by means of dashboard or logs, scheduled retraining jobs using new data by means of Airflow or Cron, use of ML flow for model versioning.

Table is showing the different task involved for our model along with tools used for performing the specified task

Table 3: Task and tools used for model

Task	Tools
Pre-processing	pandas, sklearn, openpyxl
Modeling	sklearn, xgboost, indicbert ,lstm
Visualization	seaborn, matplotlib, plotly
API	Flask, FastAPI
UI	Streamlit, Gradio
Deployment	Docker, AWS/GCP
Experiment Tracking	MLflow

7. Expected outcome of research work:

The expected outcome of research work are as follows:

i. **Development of an Intelligent Budgeting Framework:** The research work will help in the development of a model which utilizes computational intelligence techniques like deep learning for forecasting, analysing and optimize financial budget for the state of Uttarakhand.

ii. **Improved forecast Accuracy:** The proposed model aims to help in enhancing the ability to predict revenues, expenditures and deficits more accurately using historical and real-time data.

iii. **Data-driven Decision-Making:** The proposed model intends to help the government bodies with evidence -based insights for better allocation of resources and prioritization of development sectors.

iv. **Customization of Financial models for Uttarakhand:** Model will help in creating budgeting tools by considering the unique economic, geographical and disaster prone characteristics of Uttarakhand.

v. **Efficiency and transparency in budgeting:** The proposed model will reduce the manual errors, increase in process of automation and enhancing the transparency in preparation of budget and monitoring of budget.

vi. **Recommendation for policy makers:** The proposed model will provide policy-level suggestions for adopting computational intelligence based tools in state- level financial planning.

vii. **Prototype or Tool demonstration:** The proposed model will be able to create a working prototype or dashboard model showing how computational Intelligence algorithm helps in financial budgeting and analysis.

8. Proposed Chapterisation:

The entire research work will be divided into following chapters for elaborating our research work:

Chapter 1 will focus on introduction of the topic which will contain notes on financial and budgeting process with respect to India along with different computational intelligence based algorithms which will be used for our research work. This chapter will also discuss the research problems pertaining to research work.

Chapter 2 will be devoted to literature review work focusing on different techniques used for financial analysis. The literature review will be helpful in finding research gap and further it will be used in framing our research objectives for proposed research work.

Chapter 3 would include the methods and algorithms along with approaches used in our research work. This chapter will discuss and explain the algorithm being used in our research work and process flow.

Chapter 4 will discuss about the method and methodology adopted and implementation plan of our research work. This chapter will discuss the implementation in details that how our model is created and it's working will be discussed in this chapter.

Chapter 5 will discuss the results of proposed work. A detailed comparative analysis which will compare our work with the others will be undertaken. Further, we will also discuss the future scope of study in the proposed area.

9. Proposed Month-wise plan of work and targets to be achieved:

S. No.	ACTIVITIES	Months-Year														
		J-25	A- 25	S-25	O- 25	N- 25	D- 25	J- 26	F-26	M-26	A-26	M-26	J-26	J-26	A-26	S-26
1	Thesis Proposal defense															
2	Extended Literature Review															
3	Questionnaire designing															
4	Pilot testing and refinement of															
5	Data collection															
9	Data preparation															
10	Data analysis & Results															
11	Report writing: Chapter1: Chapter 2															
12	Report writing: Chapter 3:															
14	Thesis Writing, Publications and Other Requirements															
15	Thesis Submission															

*Month and Year is given just for sample only. Use your proposed month and year in which expected to complete the activity

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